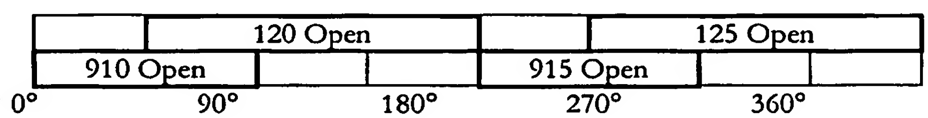
CLAIMS

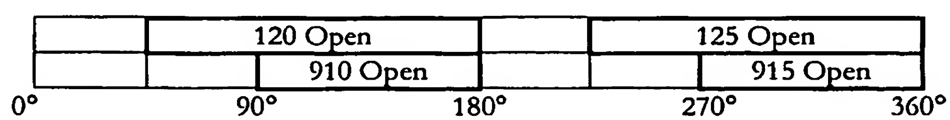
1. A method of shifting a G-M type pulse tube from a cooling mode to a warming mode using valves to change the phase relationship of the flow to the warm end of the regenerator relative to the flow to the warm end of the pulse tube.

2. A pulse tube refrigerator, comprising at least one regenerator, at least one pulse tube, a connecting tube, a first gas line, a second gas line, a first valve 120, a second valve 125, a third valve 910, a fourth valve 915, a cold heat station, and a hot heat station wherein the first gas line brings high-pressure gas from a compressor and the second gas line returns gas at low pressure to the compressor, the first valve 120 admits high-pressure gas to the warm end of the regenerator and the second valve 125 returns gas from the warm end of the regenerator to the compressor; third valve 910 admits high-pressure gas to the warm end of the pulse tube and the fourth valve 915 returns gas from the warm end of the pulse tube to the compressor; the connecting tube connects the cold end of the regenerator with the cold end of the pulse tube such that heat is picked up at the cold end of the pulse tube in the cold heat station and transferred to ambient temperature from the hot heat station or returned to the compressor through the fourth valve 915

cooling is produced at the cold end of the pulse tube refrigerator when the valve timing is approximately



and when the timing of opening and closing valves 910 and 915 relative to valves 120 and 125 is changed to



work energy transfers from ambient temperature to the cold end of pulse tube 165 causing the cold end of pulse tube 165 to warm up.

3. The refrigerator of claim 2 also comprising a buffer tank connected to the warm end of pulse

tube through a flow restrictor or a fifth valve 205 that controls the timing of flow in and out of the buffer tank and to the line connecting valves 910 and 915.

4. The refrigerator of claim 3 where a fifth valve 205 is used for timing of flow and the valve timing for the normal cooling mode is

	120 Open				125 Open		
205				205			
	190 Open				915 Open		

0° 90° 180° 270° 360°

and for the warm up mode is

	120 Open				125 Open		
		205				205	
915			910 Open				915

0° 90° 180° 270° 360°

5. The refrigerator of claim 3 where the buffer tank is connected to the warm end of pulse tube through a flow restrictor.

6. A pulse tube refrigerator with active buffer control, where shifting a G-M type pulse tube from a cooling mode to a warming mode using valves changes the phase relationship of the flow to the warm end of the regenerator relative to the flow to the warm end of the pulse tube and where gas from the compressor flows through a first gas line into the warm end of a regenerator through a first valve 120, gas returns to the compressor from regenerator through a second valve 125 and a second gas line, gas flow to and from the warm end of pulse tube comes through a third valve 510 and a fourth valve 512 which connect to a first buffer tank and through fifth valve 520 and sixth valve 522 which connect to a second buffer tank.

7. The refrigerator of claim 6 where the valve timing for the normal cooling mode is

	120 Open				125 Open		
			510				520
512				522			

0° 90° 180° 270° 360°

and the valve timing during warm up mode is

	120 Open				125 Open		
			510				520
	522				512		

0° 90° 180° 270° 360°

8. A GM type pulse tube refrigerator, comprising a regenerator having a warm end and a cold end, a pulse tube having a warm end and a cold end, the cold end of the pulse tube being connected to the cold end of the regenerator, and a valve mechanism that cycles gas flow to the warm end of the regenerator and to the warm end of the pulse tube, where the phase relation of gas flow to the regenerator and to the pulse tube produces one of cooling or heating at the cold end of the pulse tube depending on the configuration of the valve mechanism.

9. A pulse tube refrigerator as in claim 8 where said valve mechanism consists of a primary rotary disc and a secondary rotary disc on a common drive shaft.

10. A valve mechanism as in claim 9 where the angular position of said secondary disc shifts relative to said primary disc when the direction of rotation is reversed.

11. A pulse tube refrigerator as in claim 8 wherein a cryopanel is attached to a heat station at the cold end of said pulse tube.

12. A pulse tube refrigerator with a cryopanel as in claim 11 wherein said change of phase relation is used to warm-up the cryopanel.